# Thyristor Commutation Techniques

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Commutation means bringing the thyristor from forward conduction state to forward blocking state i.e. it is a process of turning off a thyristor.

**Remember:**

- Commutation technique use resonant LC or underdamped RLC circuits to force the current or voltage of SCR to zero to turn-off the device.

## Types of Commutation

1. **Natural Commutation (Line Commutation):** Here nature of supply take cares of commutation process.

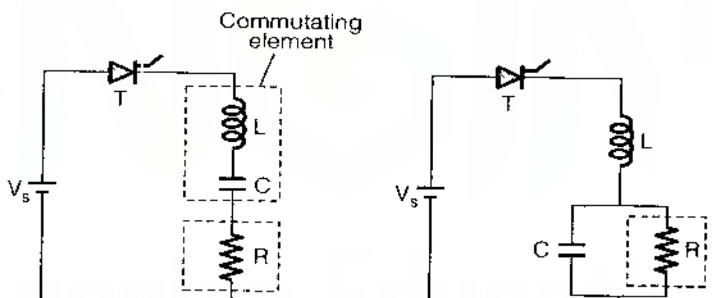
   **Example:** Phase controlled rectifier and AC voltage controller.

2. **Force Commutation:** Here external component bring anode current to zero forcefully.

   **Example:** Chopper and inverter.

## Types of Force Commutation Circuit

### (a) Class A (Load Commutation):




For low R load      For high R load

❑ **Over all circuit must be underdamped.**

i.e. $$R^2 < \frac{4L}{C}$$

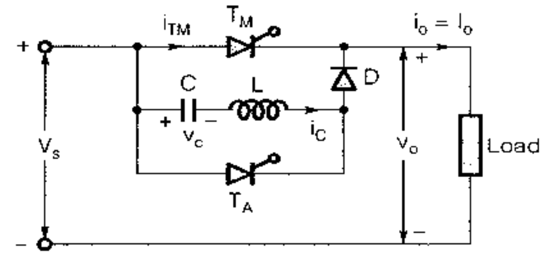
- This type of commutation is possible in dc circuit not in ac circuit.
- Load commutation is also called resonant commutation or self commutation.

### (b) Class B Commutation:

- It is also called as current commutation or resonant pulse commutation.

  Assumption:

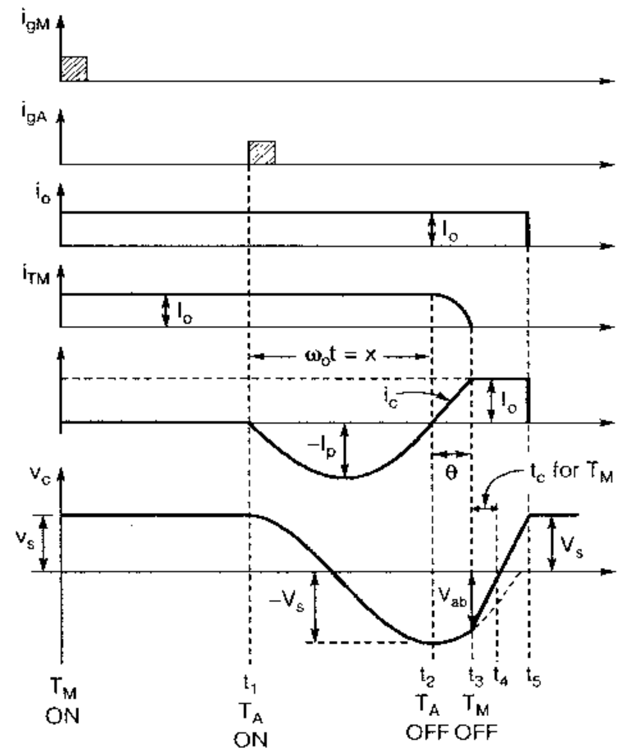
  1. Load current is assumed constant.
  2. The capacitor is initially charged with $V_s$ volt with left plate positive and right plate negative.




Here, $T_A$ = Auxiliary thyristor and

$T_M$ = Main thyristor

- Commutation process is initiated by switching ON the auxiliary thyristor.



- Resonant current

$$i_c = -V_s\sqrt{\frac{C}{L}}\sin\omega_o t = -I_p \sin\omega_o t$$

- Peak resonant current

$$I_p = V_s\sqrt{\frac{C}{L}}$$

- Circuit turn-off time for main thyristor ($T_m$)

$$t_c = C\frac{V_{ab}}{I_o}$$

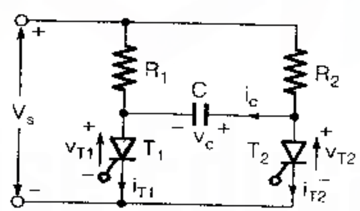
- Reverse voltage across main thyristor

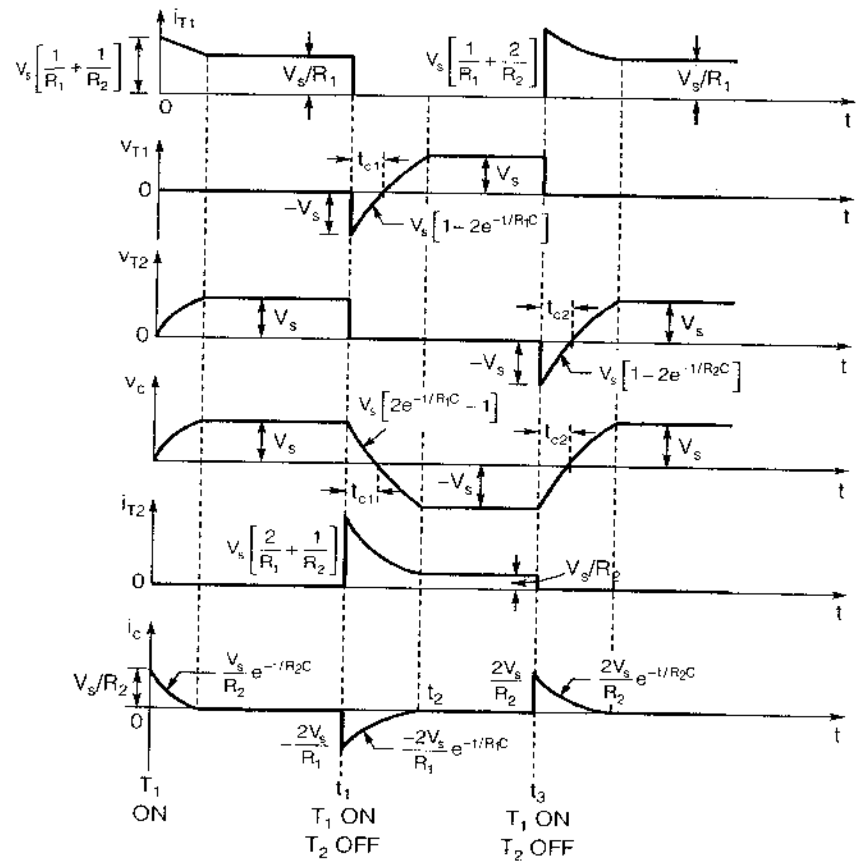
$$V_{ab} = V_s \cos\left[\sin^{-1}\left(\frac{I_o}{I_p}\right)\right]$$

Conduction time of auxiliary thyristor = $\pi\sqrt{LC}$

**(c) Class C Commutation:**

It is also called, complementary impulse commutation.




**Case-1:** When $T_1$ is turned ON at t = 0, $T_2$ is off

- **The charging current** (when capacitor is initially uncharged)

$$i_c = \frac{V_s}{R_2}e^{-t/R_2C}$$

- Voltage across capacitor C

$$v_c(t) = V_s\left(1 - e^{-t/R_2C}\right)$$

**Case-2:** When $T_1$ is to be turned OFF, $T_2$ is turned ON at $t_1$

- The charging current

$$i_c(t) = -\frac{2V_s}{R_1} e^{-t/R_1C}$$

- Voltage across capacitor C

$$v_c(t) = V_s \cdot \left[2e^{-t/R_1C} - 1\right]$$

**Note:** In last equation, time is measured from the instant $t_1$.

- Peak current thought $T_1$

$$I_{T_1,P} = V_s\left[\frac{1}{R_1} + \frac{2}{R_2}\right]$$

- Peak current through $T_2$

$$I_{T_2,P} = V_s\left[\frac{2}{R_1} + \frac{1}{R_2}\right]$$

- Circuit turn-off time for $T_1$

$$t_{c1} = R_1C\,ln(2)$$

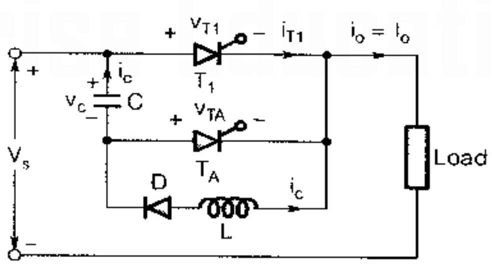
- Circuit turn-off time for $T_2$

$$t_{c2} = R_2C\,ln(2)$$

**(d) Class D Commutation:**

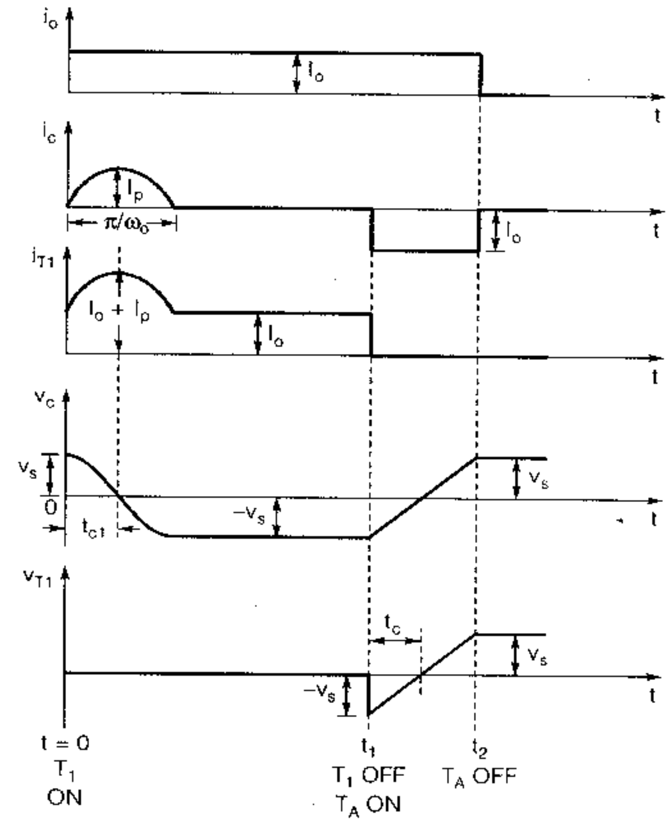
Also known as:

1. Impulse commutation
2. Voltage commutation
3. Auxiliary commutation
4. Parallel-capacitor commutation




where, $T_1$ = Main thyristor

$T_A$ = Auxiliary thyristor




**Assumption:**

1. Load current is assumed constant.
2. The capacitor is initially charged to $V_s$ as shown in figure.

- Capacitor current

$$I_c = I_p \sin\omega_o t$$

$$I_c = V_s\sqrt{\frac{C}{L}}\sin\omega_o t$$

- Peak value of current through capacitor

$$I_p = V_s\sqrt{\frac{C}{L}}$$

- Peak value of current through main thyristor ($T_1$)

$$(I_p)_{T_1} = I_p + I_o$$

- Peak value of current through auxiliary thyristor ($T_A$) = $I_o$
- Circuit turn-off time for main thyristor ($T_1$)

$$t_c = C\frac{V_s}{I_o}$$

- Circuit turn-off time for auxiliary thyristor ($T_A$)

$$t_{c_1} = \frac{\pi}{2\omega_o} = \frac{\pi}{2}\sqrt{LC}$$

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